Development of a Fine Scale Remotely-Sensed Map of Coastal Dune and Salt Marsh Cover Types at Cape Cod National Seashore

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ABSTRACT

Accurate remotely-sensed maps are a valuable tool for a wide-range of conservation and management applications, including applied ecological research and long-term landcover monitoring. In this study we used a supervised classification approach using a recently developed classification algorithm ("Random Forests") to construct a fine-scale (1-meter pixel resolution) map of an ~1,750 ha area of coastal dune and an ~ 100 ha area of salt marsh (currently being restored) at Cape Cod National Seashore (CACO). We obtained promising results with this mapping methodology and look to employ and advance this methodology for application throughout CACO.

METHODS

- We employed a supervised classification scheme, using sub-meter accuracy GPS units to field-collect "training" and "validation" points.

- Employed 100 "training" points and 50 "validation" points per class for the coastal dune cover types and 50 "training" and 25 "validation" points per class for the salt marsh cover types.

- We utilized two imagery sources, April 2005 digital orthophotographs (0.5m pixel resolution) and October 2007 Quickbird™ satellite imagery (2.44m pixel resolution), and re-sampled both to a 1.0m pixel resolution.

- Created ~ 250 input grids from the two imagery sources and a digital terrain model as potential input variables in the classification model.

- Employed the Random Forests classification algorithm to build the classification models, including some advancements to the algorithm (*see below*) that improved overall classification accuracy.

- All analyses and map-construction procedures were conducted using the R™ environment and ArcGIS ™ version 9.3 software.

MODIFICATIONS TO THE RANDOM FORESTS ALGORITHM

- We employed a forward stepwise selection method to select a subset of predictor variables to use that resulted in a higher classification accuracy compared to using the entire predictor variable set.

- We used equal sample sizes of "training" and "validation" points for each class in the two datasets to eliminate the effect of class bias on class-specific accuracies.
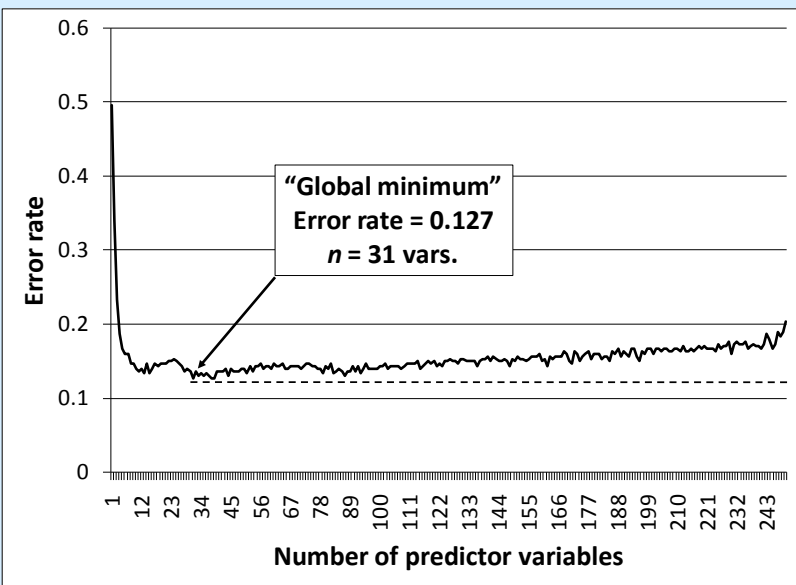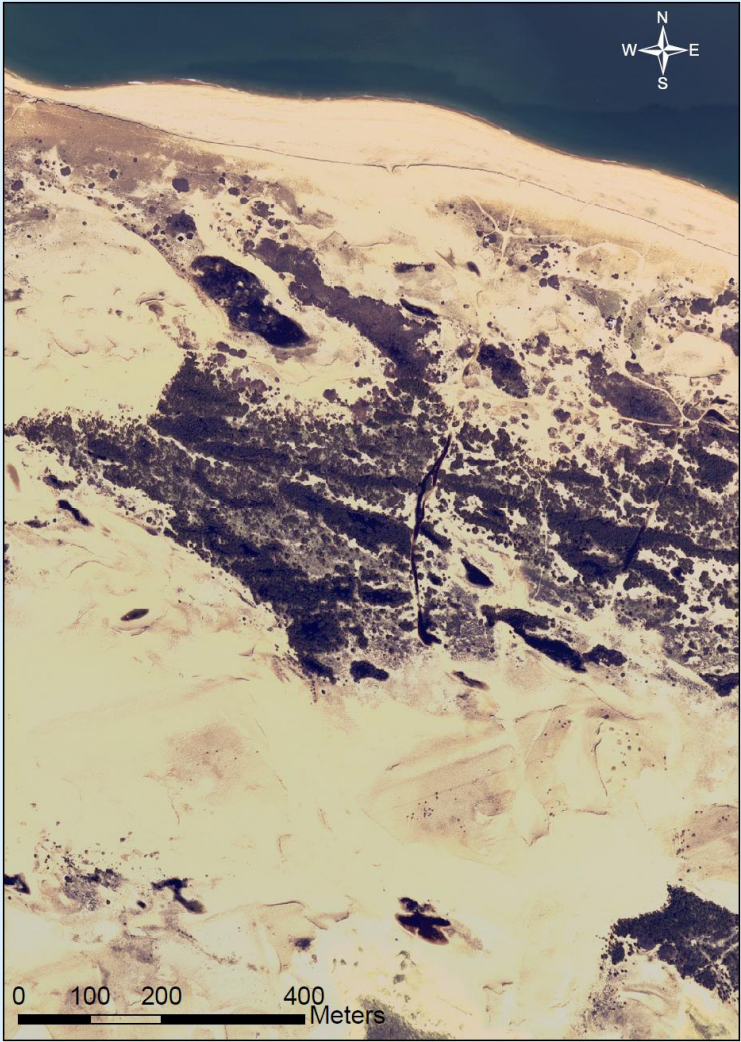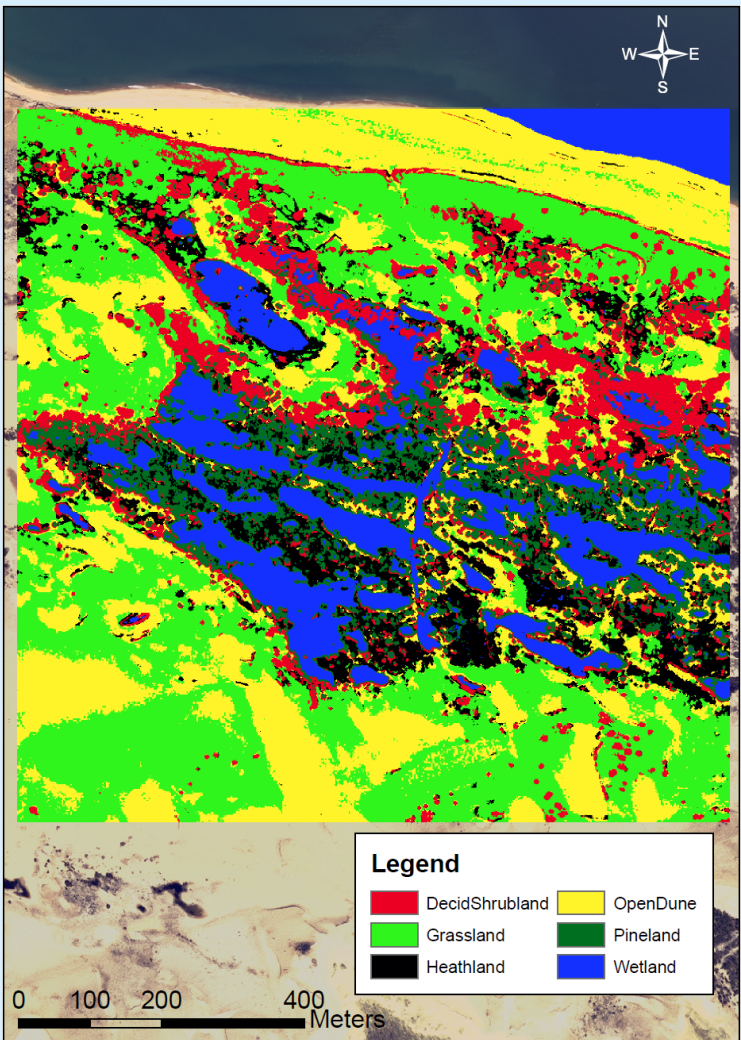

Forward stepwise selection results.
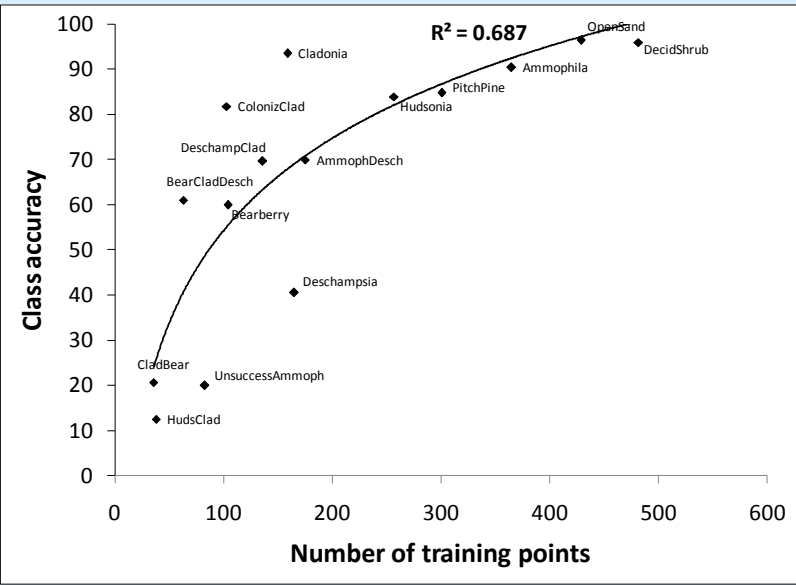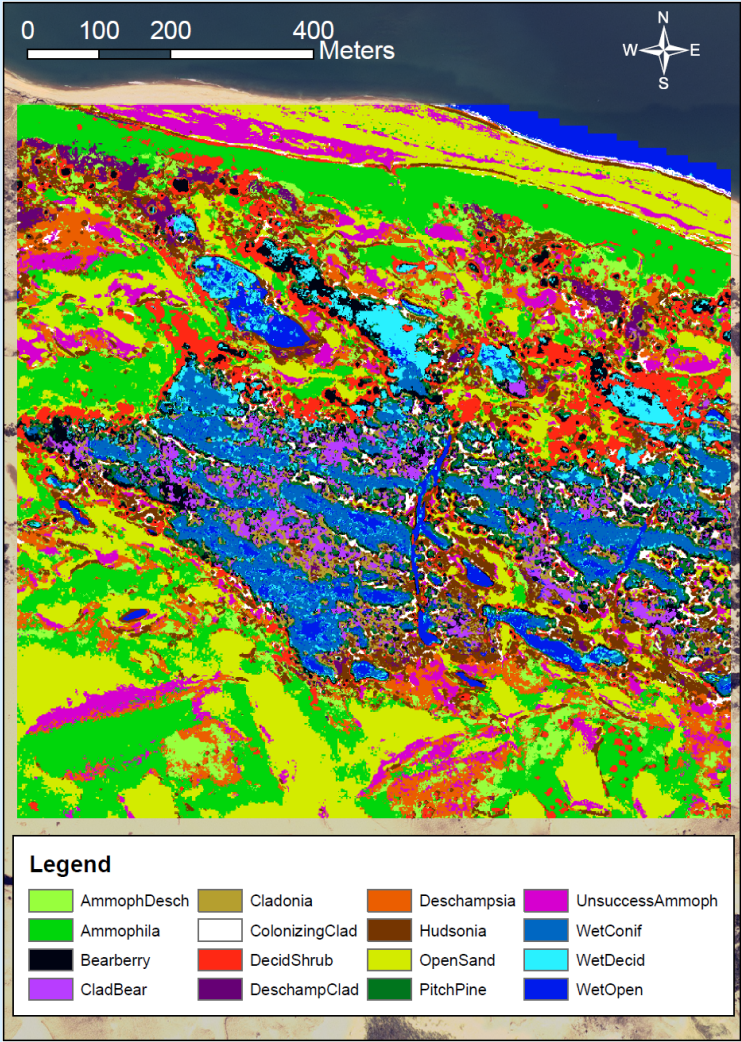

Evidence of class bias.
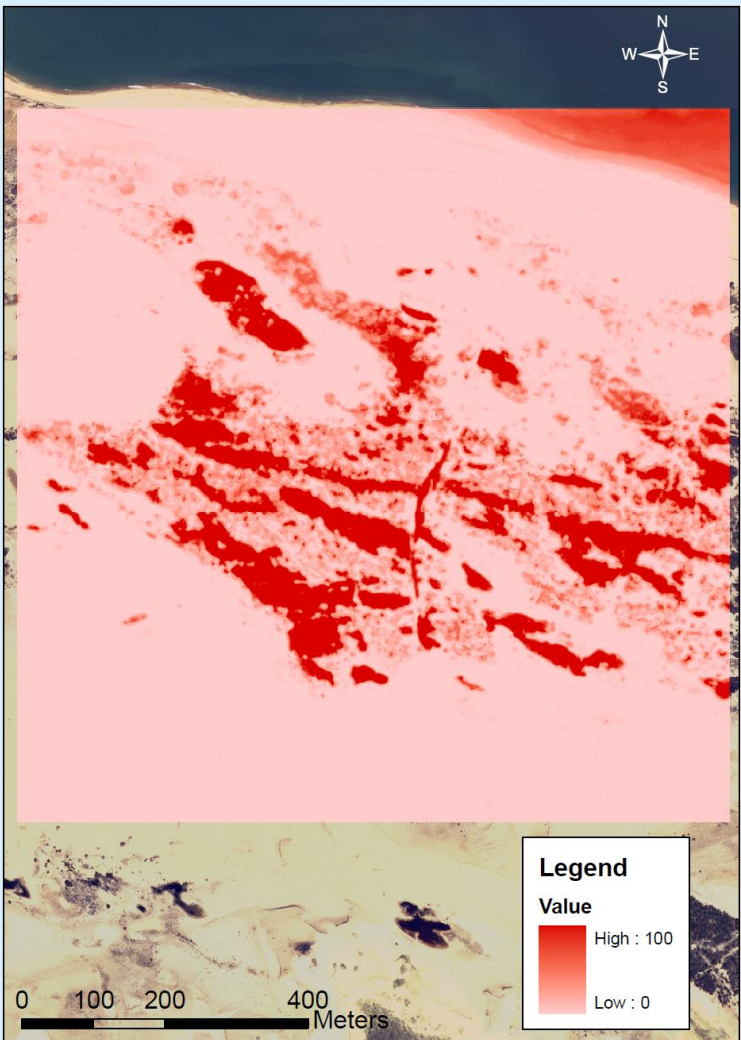
COASTAL DUNE COVER MAPS

April, 2005 orthophotograph of a 1-km^2 portion of the study area.

16-class predicted cover map. CCR = 64%. Most misclassifications were between overlapping classes.

6-class predicted cover map. CCR = 84%.

Fuzzy classification cover map; predicted probability of 'Wetland'.

WILDLIFE RESEARCH APPLICATIONS

- Will be employed to assess habitat use/preference of two rare species found at CACO (*see photos below*) using recently collected radio-telemetry data.

- Will be employed to produce predicted presence/absence and relative abundance maps for these (and potentially other) rare species at CACO.

Eastern spadefoot toad. Listed as "threatened" in Massachusetts.

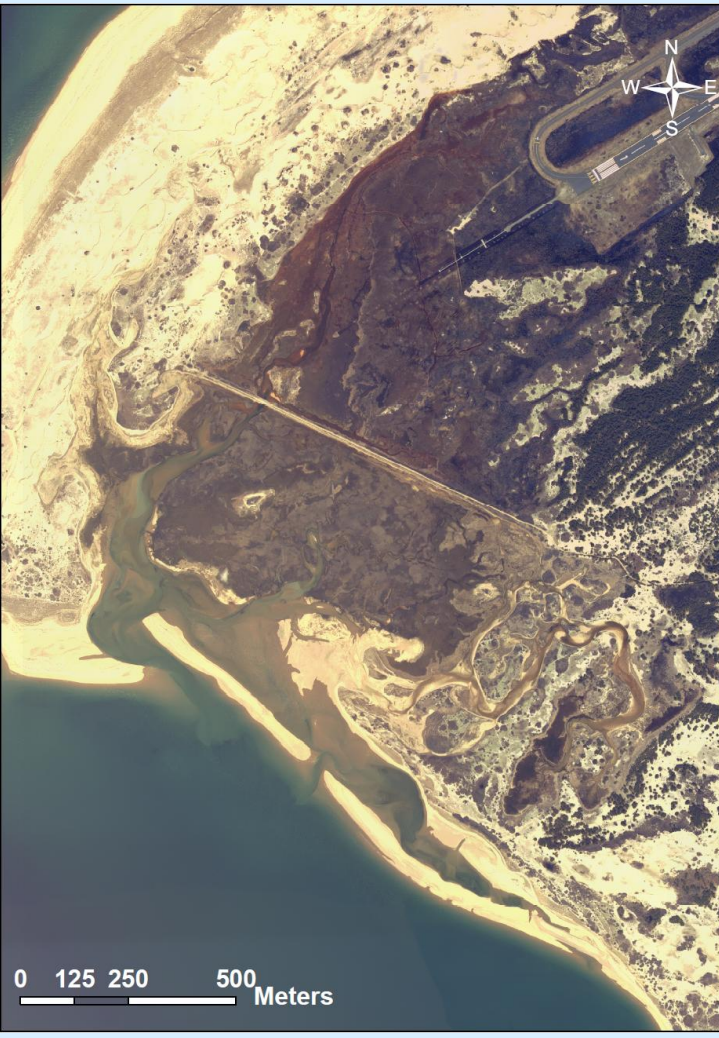Eastern hognose snake. Under review for listingin Massachusetts
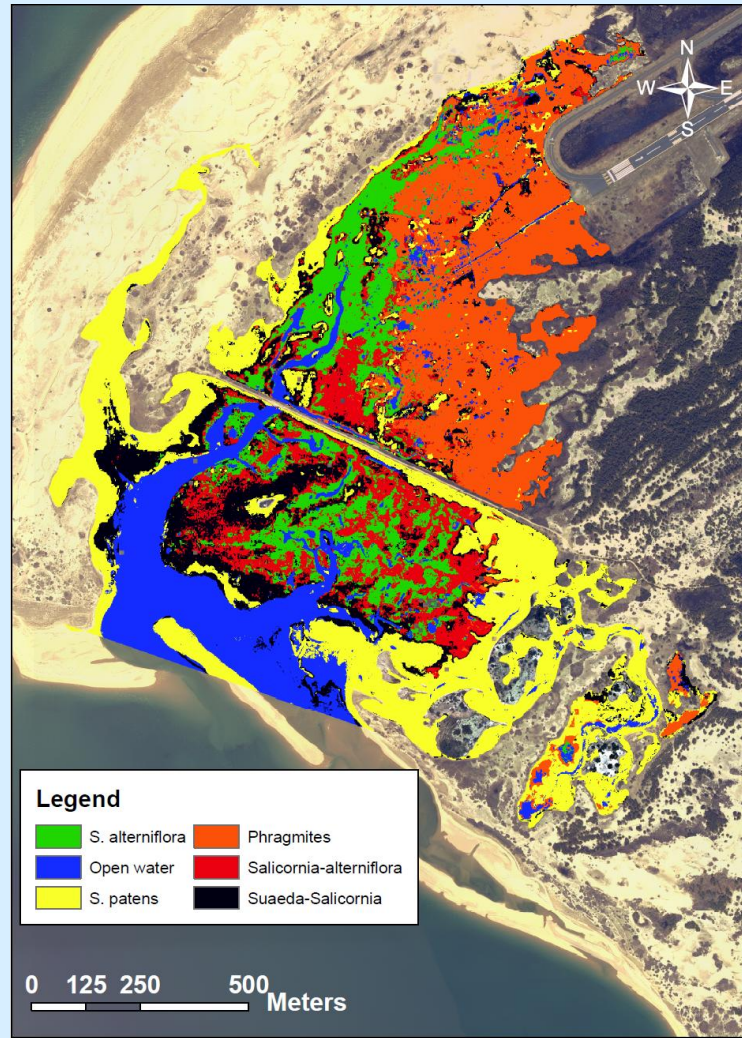
SALT MARSH COVER MAPS

Culvert installed in 1999 along the Hatches Harbor dike to restore tidal flow to the salt marsh.

Prescribed burn by CACO staff in March 2009 to reduce *Phragmites* cover at Hatches Harbor salt marsh.

April, 2005 orthophotograph of the Hatches Harbor salt marsh.

6-class predicted cover map. CCR = 82%.

CONCLUSIONS AND FUTURE WORK

- We obtained promising results for both datasets (i.e., coastal dune and salt marsh conmmunities) using the Random Forests supervised classification approach.

- Modifications to the Random Forests algorithm proved effective in increasing overall and class-specific accuracies.

- Future work will explore incorporating LiDAR datasets and tasked imagery acquisition in this Random Forests mapping approach.

- Future work will include expanding this method to other areas of CACO in similar and other community types (e.g., upland forest, kettle ponds, and riverine marshes) and comparing results to those obtained from more traditional remotely-sensing based mapping methods.